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Leaf Anatomy of *Cinnamomum tamala* and *C. impressinervium* (Lauraceae), and the Botanical Origin of Nepalese Natural Drug "Tejpat"

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Leaves of *Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm. and *C. impressinervium* Meisn. (Lauraceae) were studied in order to clarify the botanical origin of the Nepalese natural drug "Tejpat". The results showed that these species can be distinguished from each other by the presence or absence of papillae on the abaxial surface of the lamina, the differences of outline of the midribs and the number of phloem rays in the transverse sections of midribs. Tejpat obtained in Kathmandu was identified as the mixed leaves of the two species in the almost equal ratio.

Key words: *Cinnamomum tamala*, *Cinnamomum impressinervium*, leaf anatomy, Nepal, Tejpat.

Tejpat, the cinnamon leaf, is a well-known Nepalese natural drug used as an irritant and carminative, and is a remedy for abdominal acute pain, diarrhea, and rheumatism (Manandhar 1980, His Majesty's Govt. of Nepal 1997), and also a common cooking spice (Malla 1982). It has been said that Tejpat is made from the leaves of *Cinnamomum tamala* (Manandhar 1980) and one obtained in a Kathmandu market was evidently the leaves of *Cinnamomum* species based on its characteristic odor and trinerved venation. The leaf blades of the Tejpat constituents were 6–20 cm in length, and morphologically relatively uniform. On closer inspection, however, the leaves seemed to divide into two groups: Type A; the adaxial surface of midrib is almost flat, and Type B; the adaxial surface of the midrib is somewhat hollowed along the shoulders of the vein.

In Nepal, seven wild *Cinnamomum* taxa are known; *C. bejolghota* (Buch.-Ham.) Sweet, *C. camphora* (L.) J.Presl., *C. glanduliferum* (Wall.) Meisn., *C. glaucescens* (Nees) Hand.-Mazz., *C. impressinervium* Meisn., *C. parthenoxylon* (Jack) Meisn., and *C. tamala* (Buch.-Ham.) Nees & Eberm. (Hara et al. 1982). Of these, the taxa with trinerved leaves are *C. tamala*, *C. impressinervium*, and *C. bejolghota*. The leaves of the last taxon, more than 20 cm long, are extremely larger than those of the others. Therefore, the botanical origin of the Tejpat obtained was thought to be either *C. tamala* or *C. impressinervium*. In this study, to clarify the botanical origin of Tejpat, comparative anatomical studies on the leaves of *C. tamala* and *C. impressinervium* were carried out.

Results

The external morphology was observed with the naked eye and under a hand lens of

10 magnifications. The inner structure of the transverse sections of midribs at the base (at 1/6 of the blade length from the base) and the middle (at 1/2 of the blade length), and the lamina and margin at the middle were observed under an optical microscope. Moreover, the Palisade Ratio (P.R.), Vein-islet Number (ViN), and Veinlet Termination Number (VTN) were observed by the usual method (Trease and Evans 1966).

Voucher specimens of both the plant materials and Tejpat are kept in the Faculty of Pharmaceutical Sciences, Kanazawa University (KANP) and in the University Museum, the University of Tokyo (TI). (Collector's abbreviations: OHA, H. Ohashi et al.; OHB, H. Ohba et al.; MM, M. Mikage et al.; SM, M. Senoo).

1. Tejpat (Fig. 1)

1) Materials: Tejpat produced in Nepal was obtained at the herbal shop of Gyan Man Jagot Hitman Singh, Kathmandu, Nepal, in August 1995 (specimen number: KANP-1590).

2) External morphology

The Tejpat is composed of entire leaves and fragments, and no shoot is mixed in. The leaf is orbicular to oblong or lanceolate oblong, 6–20 cm long, 2–6 cm wide, trinerved and coriaceous. The apex is acute to acuminate, sometimes caudate, the base is cuneate to obtuse. Through detailed observation, the leaves could be divided into two groups; Type A whose midrib is almost flat, and Type B midrib hollows along the shoulders of the vein.

2. *Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm. and Tejpat Type A (Fig. 2–A)

1) Plant materials: Central Nepal. Bagmati Zone, Kathmandu Distr.; Nagarjun, alt. 1840 m, MM0060595; id., alt. 1860 m, MM0060598. Western Nepal. Gandaki Zone, Gorkha Distr.; Sardu Khola, alt. 1820

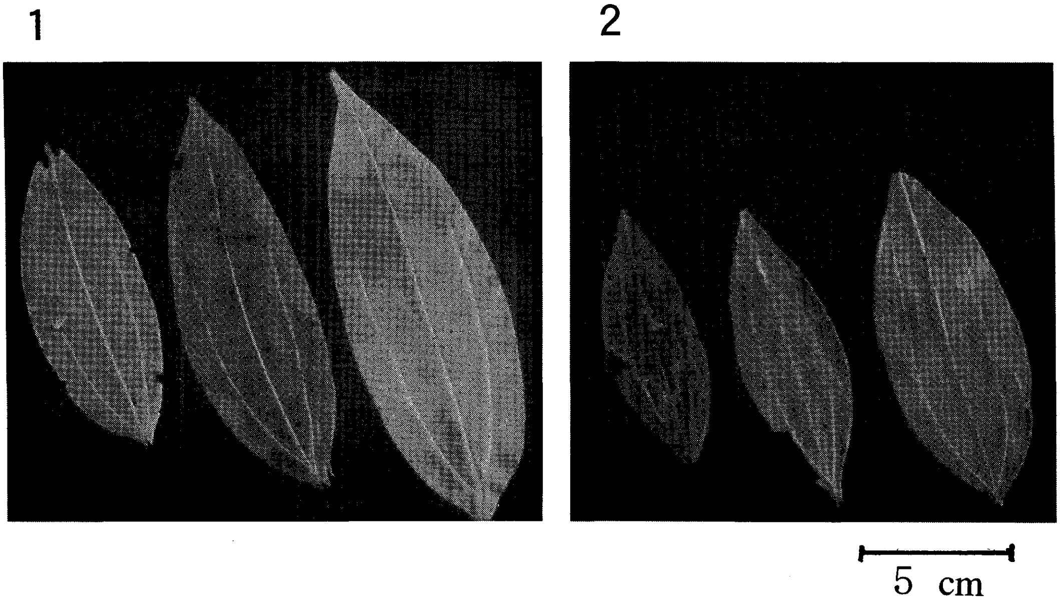

Fig. 1. Tejpat obtained in Kathmandu market. 1; Leaf Type A. 2; Leaf Type B. The surface of midrib of Type A is almost flat, and that of Type B hollows slightly along the shoulders of the vein.

m, MM9455162; id., Lokpa, alt. 1945 m, MM9460084; id., Sardu Khola, alt. 1860 m, MM9460091. Gandaki Zone, Kaski Distr.; vicinity of Tamage, alt. 1650 m, MM9966510; id., alt. 1520 m, MM9966537. Dhaulagiri Zone, Myagdi Distr.; Ghara, alt. 1580 m, MM9966551; between Beg Khora and Rahughat, alt. 1020 m, MM9961320.

2) External morphology

Leaves coriaceous, oblong to lanceolate-oblong, 6–20 cm long, 2–6 cm wide, acute to acuminate, or sometimes caudate at apex, cuneate to rounded at base, trinerved; two lateral veins diverged from the midribs near the base and terminate at 3/5–4/5 from the base. No hair is observed on adaxial surface,

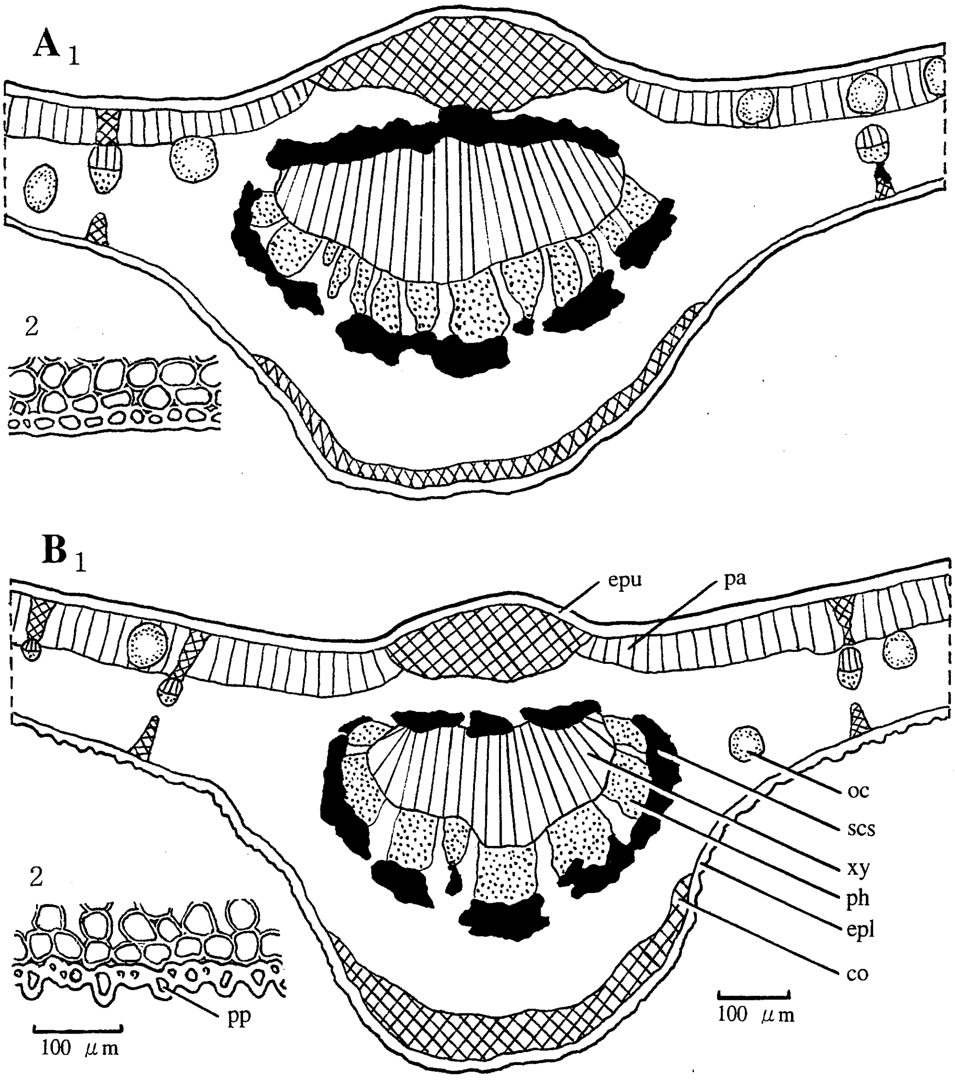

Fig. 2. Transverse sections at the middle of leaves of *Cinnamomum* spp. in Nepal. A; *C. tamala*. B; *C. impressinervium*. 1; midrib. 2; lower epidermis. Abbreviations: co, collenchyma tissue; epl, lower epidermis; epu, upper epidermis; oc, oil cell; pa, palisade tissue; ph, phloem; pp, papilla; scs, sclerenchymatous sheath; xy, xylem.

and a few on abaxial surface under a hand lens.

3) Internal structure

In transverse section, midrib broadly convex to both adaxial and abaxial sides, 410–700 μm thick at the middle, and 500–860 μm at the base of the leaf. Leaf margin slightly outcurved. Cuticle layer 1–5 μm thick covers epidermis, thicker on midrib and margins than on lamina, and thicker on adaxial surface than on abaxial surface of lamina. Epidermis is one cell layer, 9–16 μm thick in the upper and 8–13 μm in the lower epidermis, both the surfaces are almost flat.

In the midrib, beneath the epidermis of both adaxial and abaxial surfaces, mechanical tissues composed of sclerenchyma and collenchyma cells are present, numbering 115–241 at the middle and 167–324 at the base of the leaf. In this tissue, several oil cells (diameter 32–72 μm) are apparent. One large collateral vascular bundle, orbicular to reniform in shape, is present in the center of the midrib, surrounded by a sclerenchymatous sheath of 1 to 4 fibrous cell layers in the endodermis position. The large vessel is 30–45 μm in diameter. One to five rays are recognized in the phloem.

In the lamina, palisade tissue of 1–2 cells thickness and spongy tissue of 2–4 cells thick are apparent. The palisade parenchyma cell is 37–63 μm long. Oil cells of 30–80 μm diameter are recognized in the both tissues.

In surface view, upper epidermal cells are amorphous in shape with undulate cell walls, 20–38 μm in diameter. Stomata are obvious on the abaxial surface, and the stomatal complex pattern is paracytic. P.R.: 2–2.5–3.0, ViN: 24–30.2–37, VTN: 0–2.0–4.0.

Sclerenchyma tissue develops, and oil cells are apparent in the leaf margin.

3. *Cinnamomum impressinervium* Meisn. and Tejpat Type B (Fig. 2–B)

1) Plant materials: Eastern Nepal. Kosi Zone, Sankhuwasabha Distr., between Fururu and Num, alt. 2050–1600 m, OHA774555 (TI). Central Nepal. Janakpur Zone, Dolakha Distr., between Phedi Kharka and Khanigaon, alt. 2100–1700 m, OHB8340507 (TI).

2) External morphology

Leaf shape is almost the same to that of *C. tamala*, but size is smaller, 6–12 cm long and 2–5 cm wide. The lateral veins reach to near the apex. The shoulders of the midrib are slightly concave. Leaf is coriaceous and more sclerophyllous than that of *C. tamala*. No hair is observable with the naked eye, scarce hairs are recognized under a hand lens on abaxial surface.

3) Internal structure

The internal structure of the leaf in the transverse section is basically the same as for *C. tamala*.

Midrib broadly and strongly convex on the abaxial side of the lamina, slightly raised above the lamina on the adaxial side, 420–743 μm thick at the middle, and 564–833 μm thick at the base of the leaf. Leaf margin slightly outcurved. Epidermis is 9–16 μm thick in adaxial and 8–23 μm in abaxial sides.

In the midrib, beneath the epidermis of both adaxial and abaxial surfaces, mechanical tissues composed of sclerenchyma cells or of both sclerenchyma and collenchyma cells are apparent, there are 56–170 mechanical cells at the middle, 90–189 at the base of the leaf. In this tissue, several oil cells (diameter of 32–72 μm) can be seen. One large collateral vascular bundle, orbicular to reniform in shape, is present in the center of the midrib, surrounded by a sclerenchymatous sheath composed of 1 to 4 fibrous cell layers. The large vessel is 21–35 μm in diameter, 6–11 rays are apparent in the phloem.

In the lamina, palisade tissue composed of 1–2 cell layers and spongy tissue of 2–4 cell layers are seen. The palisade parenchyma cell is 40–78 μm long. Oil cells of 30–80 μm in long diameter are recognized in both tissues. Lower epidermal cells are characteristically papillose (Fig. 1–B2), while the upper epidermal cells are not.

In the surface view, the upper epidermal cells are amorphous in shape with undulate cell walls, 25–43 μm in diameter. The cell wall of lower epidermal cells is also extremely sinuate. Stomata are obvious on the abaxial surface. P.R.: 1.50–2.20–2.75, ViN: 21–25.7–30, VTN: 0–1.3–2.0.

Conclusions

1. The comparative anatomical study of the leaves of *Cinnamomum tamala* and *C. impressinervium* growing in Nepal showed that the latter was distinguished clearly from the former by anatomical features, such as, papilla on the abaxial surface, larger projection of midrib to abaxial side, fewer phloem rays, etc.
2. The Tejpat obtained in Kathmandu was identified as the mixed leaves of *Cinnamomum tamala* and *C. impressinervium* in an almost equal ratio. This is the first report that the leaf of *C. impressinervium* is circulated in Nepalese market as a natural drug. The species has reported as one of botanical origins of Tejpat in eastern Himalayan region of India (Subhan 1998).
3. The shoulders of midrib were not concave in the transverse section of the leaf of *C. impressinervium*, though the dried leaves have hollows along the midrib. We think the hollows may be caused by different shrinking degree of sclerenchyma tissue beneath the upper epidermis of the midrib and parenchyma tissue surrounding the sclerenchyma tissue. The details are unclear.
4. The main components of the essential oil contained in the leaf of *C. tamala* are linalool, α-pinene, ρ-cymene, β-pinene, limonene, etc., while cinnamic aldehyde content is low and no eugenol has been recorded for it (Upadhaya 1994). It has been reported that the main component in the essential oil of *C. impressinervium* was eugenol (Subhan Anil 1994). If this is the case, the pharmaceutical effects of these species are expected to be different from each other. Further pharmaceutical study on each species should be necessary.

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References

Hara H., Chater A. O. and Williams L. H. J. 1982. An Enumeration of the Flowering Plants of Nepal **3**: 182–184. British Museum, London.

His Majesty's Govt. of Nepal, Ministry of Forests and Soil Conservation Department of Plant Resources. 1997. Medicinal Plants of Nepal, pp. 64–65.

Malla S. B. (ed.) 1982. Wild Edible Plants of Nepal, 81. Dept. of Medicinal Plants, Ministry of Forests & Soil Conservation, Kathmandu.

Manandhar N. P. 1980. Medicinal Plants of Nepal Himalaya, p. 31. Ratna Pustak Bhandar, Kathmandu.

Subhan C. N. 1998. Commercial resources of *Cinnamomum* species in eastern Himalayan region of India, ENVIS Bulletin-Himalayan Ecology & Development **6**: 21.

—— and Anil K. S. B. 1994. Eugenol as the major component of the leaf oils of *Cinnamomum impressinervium* Meissn. J. Essent. Oil Res. **6**: 211–212.

Trease G. E. and Evans W. C. 1996. A Textbook of Pharmacognosy, pp. 704–707. Bailliere, Tindall and Cassell, London.

Upadhaya S. P., Kirihata M. and Ichimoto I. 1994. Cinnamon leaf oil from *Cinnamomum tamala* grown in Nepal. J. Jpn. Soc. Food Sci. Tech. **41**: 512–514.

御影雅幸，妹尾昌幸：***Cinnamomum tamala* と *C. impressinervium*（クスノキ科）の葉の組織形態ならびにネパール産生薬 “Tejpat” の原植物**

ネパールのカトマンズ市場で，クスノキ科のニッケイ属 *Cinnamomum* 植物の葉に由来すると思われる生薬 “Tejpat” を入手した．葉は三行脈で，詳細に観察すると中央脈上面がほぼ平坦なもの（A タイプ）と，脈の両肩がわずかに凹むもの（B タイプ）に分けられた．ネパールの同属植物の中で三行脈を有するものは *C. bejolghota* (Buch.-Ham.) Sweet, *C. tamala* (Buch.-Ham.) Nees & Eberm., *C. impressinervium* Meisn. の 3 種であり，そのうち *C. bejolghota* の葉は長さが20 cm をこえる大型で，商品とは大きく異なった．そこで，“Tejpat” の原植物を解明する目的で *C. tamala* と *C. impressinervium* の葉を比較組織学的に検討した．その結果，横折面において，前者に比して後者の中央脈が下面側に大きく突出すること，葉肉部の下面表皮細胞が著しく乳頭状突起化すること，また篩部放射組織が少ないことなどで明らかに区別され，前者が A タイプ，後者が B タイプであることが明らかになった．以上の結果に基づいて市場品を検討した結果，商品はこれら 2 種のほぼ等量混合物であることが明らかになった．本論文はネパールで *C. impressinervium* が薬用に供されていることを示す最初の報告である． （金沢大学薬学部）

第78巻 5 号正誤 Errata in Vol. 78 No. 5

ページ（*Page*）	カラム（*Column*）	行（*Line*）	誤（*For*）	正（*Read*）
293	Left	↓13	var. *philippinensis*	var. *palawanensis*
293	Left	↓19	var. *palawanensis*	var. *philippinensis*